Boccaccino. Removing to Rome, he stayed fifteen months with Giovanni Baldini, acquiring a solid style of draughts­manship, and finally to Mantua, where he remained two years with Lorenzo Costa. He then entered the service of the marquis Francesco Gonzaga. Afterwards he went to Ferrara, and worked there four years, showing diligence and delicacy without much severity or elevation of style. Attracted by Raphael’s fame, and invited by a Ferrarese gentleman, Geronimo Sagrato, he again removed to Rome, and found the great painter very amicable ; here he stayed two years, rendering some assistance in the Vatican frescos. From Rome family affairs recalled him to Ferrara; there Duke Alphonso I. commissioned him to execute paintings, along with the Dossi, in the Villa di Belriguardo and in other palaces. Thus the style of Tisio partakes of the Lombard, the Roman, and the Venetian modes. He painted extensively in Ferrara, both in oil and in fresco, two of his principal works being the Massacre of the Innocents (1519), in the church of S. Francesco, and the Betrayal of Christ (1524), accounted his masterpiece. For the former he made clay models for study and a lay figure, and executed every­thing from nature. Both in the Ferrarese territory and in Rome his pictures of small dimensions are very numerous. He continued constantly at work until in 1550 blindness overtook him,—an affliction which he bore with patience, being a man of pleasant friendly disposition and of devout feeling. In the later years of his work he painted on all feast-days in monasteries for the love of God. He had married at the age of forty-eight and died at Ferrara on 6th (or 16th) September 1559, leaving two children.

Garofalo combined sacred inventions with some very familiar details. A certain archaism of style, along with a strong glow of colour, suffices to distinguish from the true method of Raphael even those pictures in which he most closely resembles the great master, and this is sometimes wry closely. He was a friend of Giulio Romano, Giorgione, Titian, and Ariosto ; in a picture of Paradise he painted this poet between St Catherine and St Sebastian. In youth he was fond of lute-playing and also of fencing. He ranks as the best of the Ferrarese painters ; his leading pupil was Giro­lamo Carpi. The Adoration of the Magi, in the church of St George near Ferrara, and a Peter Martyr, in the Dominican church, Ferrara (sometimes assumed to have been done in rivalry of Titian), are among his principal works not already mentioned. The Palazzo Chigi and the Palazzo Borghese contain numerous examples, and the London National Gallery four, one of them being a Madonna and Christ enthroned, with St Francis and three other saints.

TITANIUM (atomic weight @@1 = 48⋅08, O=16), desig­nates in chemistry a relatively rare element, which is cus­tomarily classed with the metals, although it comes nearer in its character to silicon than to any of the ordinary metals. Its discovery as an element was due to William Gregor, who found in the mineral menaccanite a new earth, which was regarded as the oxide of a new metal, menachin. Independently of him Klaproth in 1793 discovered a new metal in rutile and called it titanium; he subsequently found that it was identical with Gregor’s element. The latter name was, however, retained. Titanium, although pretty widely diffused throughout the mineral kingdom, is not found in abundance. The commonest titanium mineral is rutile (TiO2) ; anatase and brookite, though mineralogically different from rutile and each other, are forms of the same binoxide.

Metallic titanium is little known. In 1822 Wollaston examined a specimen of those beautiful copper-like crystals which are occa­sionally met with in iron-furnace slags, and declared them to be metallic titanium. This view had currency until 1849, when Wohler showed that the crystals are a compound, Ti(NC)2+3Ti3N2, of a cyanide and a nitride of the metal. Real titanium was made by Wohler and Deville in 1857 by heating to redness fluo-titanate of potassium (see below) in vapour of sodium in an atmosphere of dry hydrogen, and extracting the alkaline fluoride formed by water. The metal thus produced had the appearance of iron as obtained by the reduction of its oxide in hydrogen. When heated in air, it burns brilliantly, with the formation of binoxide. Its most curi­

ous property is the readiness with which it unites with nitrogen gas into a nitride. The exact composition of this nitride is not known ; but when heated in hydrogen it loses part of its nitrogen as am­monia, and becomes Ti5N6, a metallic-looking yellow solid, and this when heated in nitrogen gas passes into higher nitrides, which are again available for the production of ammonia. Tessié du Mothay in 1872 proposed to utilize these reactions for the production of ammonia from atmospheric nitrogen. Of other titanium compounds the most important are those formed on the type of TiX4, when X = Cl,Br, or ½O, &c.

The binoxide TiO2 exists as rutile. One method of preparing a purer oxide from the mineral is to fuse it, very finely powdered, with six times its weight of bisulphate of potash in platinum, then extract the fuse with cold water, and boil the filtered solution for a long time. Titanic oxide separates out as a white hydrate, which, however, is generally contaminated with ferric hydrate and often with oxide of tin, SnO2. A better method is Wohler’s. He fuses the finely powdered mineral with twice its weight of carbonate of potash in a platinum crucible, pounds the fuse, and treats it in a platinum basin with aqueous hydrofluoric acid. The alkaline titan­ate first produced is converted into crystalline fluo-titanate, TiF6K2, which is with difficulty soluble, and is extracted with hot water and filtered off. The filtrate, which may be collected in glass vessels if an excess of hydrofluoric acid lias been avoided, deposits the greater part of the salt on cooling. The crystals are collected, washed, pressed, and recrystallized, whereby the impurities are easily removed. The pure salt is dissolved in hot water and decomposed with ammonia to produce a slightly ammoniacal hydrated oxide ; this, when ignited in platinum, leaves pure TiO2 in the form of brownish lumps, the specific gravity of which varies from 3⋅9 to 4⋅25, according to the temperature at which it was kept in igniting. The more intense the heat the denser the product. The oxide is fusible only in the oxy-hydrogen flame. It is insoluble in all acids, except in hot concentrated sulphuric, when finely powdered. Sup­posing the excess of vitriol to have been boiled away, the residue, after cooling, dissolves in cold water. The solution, if boiled, de­posits its titanic oxide as a hydrate called meta-titanic acid, be­cause it differs in its properties from ortho-titanic acid, obtained by decomposing a solution of the chloride in cold water with alka- lies. The ortho-body dissolves in cold dilute acids ; the meta-body does not. If titanic oxide is fused with excess of alkaline carbonate it expels CO2 parts of carbonic acid for TiO2 parts of itself. The salt R2OTiO2 is decomposed by water with the formation of a solu­tion of alkali free of titanium, and a residue of an acid titanate, which is insoluble in water but soluble in cold aqueous mineral acids.

The chloride TiCl4 is obtained as a distillate by heating to dull redness an intimate dry mixture of the binoxide and ignited lamp- black in dry chlorine. The reaction may be carried out in a hard glass tube. For methods of purification we refer to the handbooks of chemistry. The pure chloride is a colourless liquid of 1 ⋅7604 specific gravity at 0o C., boiling at 136o⋅4 under 753⋅3 mm. pressure (T. E. Thorpe). It fumes strongly in moist air. When dropped very cautiously into cold water it dissolves into a clear solution, which, however, when boiled, deposits most of its oxide in the meta-hydrate form. There are, at least, two lower chlorides of titanium,—one of the composition Ti2Cl6 and another of the com­position TiCl2, both solids and both extremely prone to pass into titanic compounds. A solution of the tetrachloride in water, as well as of the soluble hydroxide in dilute acid generally, when kept in contact with metallic zinc, is reduced to one of the lower chlorides with development of a violet colour. With regard to the detection of titanium we need not add much to what we have already given incidentally. Acid solutions of TiO2 are not precipitated by sul­phuretted hydrogen ; but sulphide of ammonium acts on them as if it were ammonia, the H2S being liberated. Oxide of titanium when fused with microcosmic salt (i.e., NaPO3) in the oxidizing flame yields a bead which is yellowish in the heat but colourless after cooling. In the reducing flame the bead becomes violet, more readily on the addition of tin ; in the presence of iron it becomes blood-red. Titanic oxides when fused on charcoal, even with cyan­ide of potassium, yield no metal.

TITANS, powerful beings of Greek mythology, the children of Sky and Earth. According to Hesiod, the male Titans were Oceanus, Cœus, Crius, Hyperion, Iapetus, and Cronus; the female were Thea, Rhea, Themis, Mnemosyne, Phoebe, and Tethys, to whom Apollodorus adds Dione. For the rebellion of the Titans against their father Sky (Uranus), the success and reign of Cronus, and the final consignment of the Titans to Tartarus by Zeus, see Mytho­logy, vol. xvii. p. 155, and Saturn, vol. xxi. p. 320 *sq.*

TITHES. It has been explained in Sacrifice (vol. xxi. p. 133) that among ancient peoples sacrificial gifts frequently assume the character of a tribute in kind, paid

@@@1 According to T. E. Thorpe’s researches, published in 1883.